

AD641021

RESEARCH PAPER P-282

A REAPPRAISAL OF COST INCENTIVES IN
DEFENSE CONTRACTS

CLEARINGHOUSE FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION			
Hardcopy	Microfiche		
2.00	0.50	43	ma
1 ARCHIVE COPY			

John Cross

September 1966

DEPT OF DEFENSE
NOV 1 1966
REGISTRATION
A



INSTITUTE FOR DEFENSE ANALYSES
ECONOMIC AND POLITICAL STUDIES DIVISION

IDA/HQ 66-5311
Copy 46 of 125 Copies

RESEARCH PAPER P-282

A REAPPRAISAL OF COST INCENTIVES IN
DEFENSE CONTRACTS

John Cross

September 1966



INSTITUTE FOR DEFENSE ANALYSES
ECONOMIC AND POLITICAL STUDIES DIVISION

FOREWORD

The study reported in this Research Paper was undertaken in 1965 in the Economic and Political Studies Division as part of the IDA Central Research Program. Since September 1965, John Cross has been a member of the Department of Economics at the University of Michigan.

The author would like to thank Frederick Moore, John McCall, Neil Weiner, and William Niskanen for their comments on an earlier draft of this paper, and Charles Lerner for his invaluable help. Naturally, they are not responsible for the statements made herein.

CONTENTS

Foreword	ii
List of Figures	iv
List of Tables	iv
SUMMARY	v
I INTRODUCTION	1
II PARAMETERS OF INCENTIVE CONTRACTS	8
III THE INSURANCE DIMENSION	10
A. RISK	10
B. PRICE AND RISK COMPETITION	15
IV THE INCENTIVE DIMENSION	21
V THE FORESIGHT DIMENSION	24
VI EXAMINATION OF THE DATA	27
VII CONCLUSION	33

FIGURES

1 Comparison of Four Major Contract Types	3
2 Reconciliation of Expectations Through the FPIF Contract	26

TABLES

1 Defense Department Procurement from all US Business and from Small Business	13
2 Determinants of Frequency of Contract Types	18
3 Calculation of Estimated Savings from Transfer of Contracts from CPFF to Incentive	32

SUMMARY

This Research Paper focuses upon the cost-incentive provisions which appear in many defense procurement contracts. The analysis is primarily concerned with the influence of cost incentives upon efficient contract performance, and the extent to which simple cost "overruns" or "underruns" may serve as indicators of contractor efficiency.

Historically, cost overruns have been far less frequent and less substantial under incentive contracts than under cost-plus-fixed-fee contracts. This observation has been generally interpreted, specifically by Secretary McNamara, to indicate that cost performance under incentive contracts has been more efficient than under cost-plus-fixed-fee contracts. This analysis develops several possible alternative interpretations of this observed relation and tests these interpretations against several sets of Air Force and aggregate DoD contract data from various periods from 1953 through 1965.

Alternative interpretations of the observed relation of higher cost-sharing rates and reduced cost overruns are based on the condition that the nature of the contract, the estimated and adjusted target cost, the profit rate, and the sharing rate are not given parameters but are established in negotiations between the government and private contractor.

Eight independent interpretations of this relation are suggested:

- (1) The inclusion of fixed (overhead) costs in basic contract costs tends to induce the contractor to shift overhead from high- to low-sharing-rate contracts.
- (2) It is easier to induce firms to accept high sharing rates in less risky contracts--i.e., those containing relatively small overruns in the distribution of possible outcomes.
- (3) If firms do accept high risk in contracts, they will tend to "charge" for it, increasing the estimated target cost.

(4) High sharing rates give contractors an incentive to put all possible cost increases into the "adjusted cost" category, rather than permitting them to result in overruns.

(5) If the combination of estimated target cost and the sharing rate is based primarily on the need to reconcile a divergence of expectations between buyer and contractor, high sharing rates would be possible only if the difference in expectations is small.

(6) If contractors anticipate the extent of overruns and underruns, they will attempt to negotiate sharing rates which will maximize their own expected return, increasing α as the magnitude of expected underruns rises.

(7) Relatively inefficient contractors would be most willing to make low bids on contracts with low sharing rates.

(8) High sharing rates give contractors an incentive to perform the contracts efficiently.

For underrun contracts, the conclusions are generally similar, except for the following two interpretations which would tend to reverse the direction of this relation.

(9) If the combination of the estimated target cost and the sharing rate is chosen primarily to reconcile a divergence of expectations, high sharing rates would accompany relatively small underruns.

(10) Contractors are more likely to accept high-sharing-rate contracts if the variance in the cost estimate is low.

Of these ten possible interpretations, only one (number 8) implies that the use of contractual incentives influences actual cost performance, and provides a unique economic benefit to the government.

The major empirical findings that bear on the choice among these interpretations are summarized below:

(1) For a sample of recent Air Force incentive contracts with cost overruns, the percentage of the overrun, as expected, was negatively related to the sharing rate. This finding, by itself, is consistent with any one of the negotiation interpretations (1-7) or the cost-incentive interpretation (8). If the expected target cost and profit rate, however, are negotiable, it is shown that one can expect a negative relation between the percentage of the overrun and the profit rate, while the incentive interpretation would suggest no relation between these variables. For this sample of overrun contracts, such a relation did appear,

suggesting that a substantial part of the observed decline in overruns is attributable to an adjustment of estimated target costs.

(2) For a similar sample of recent Air Force contracts with cost underruns, the percentage underrun was negatively related to the sharing rate. This finding is only consistent with negotiation interpretations (9-10) and is incompatible with the cost-incentive interpretation (8).

(3) Even if the estimated target cost is not a negotiated variable, the higher profit rate needed to induce a contractor to accept an incentive contract may offset a part of the savings attributable to the cost incentives. Historically, the government has had to pay around 2.5 percent of adjusted target costs to induce a contractor to change from a cost-plus-fixed-fee contract to an incentive contract with a 20 percent sharing rate; any effects of cost incentives would have to exceed this premium to reduce the total costs to the government. For a sample of all Air Force contracts over \$1 million from 1959-1964, the net savings from the use of incentive contracts was only 3.5 percent of adjusted target cost, even if target cost is not a negotiated variable. For 1964, the net savings on AF incentive contracts was actually -5.0 percent. As the evidence clearly indicates that target costs are negotiated variables, these estimates of the net savings are higher than the true savings.

Several other empirical findings bear on the general effects of the cost incentive provisions:

(1) Small business firms receive a disproportionately small share of defense R&D contracts due to their lower relative ability to bear risk, and government efforts to increase the use of cost sharing contracts have probably reinforced this condition.

(2) Profit rates on incentive contracts have been about 2.5 percentage points higher than on cost-plus-fixed-fee contracts, but there does not appear to be any relation, within the group of incentive contracts, between the profit rate and the sharing rate.

(3) The proportion of defense procurement under fixed-price and incentive contracts has been increasing since the Korean War, but appears to be negatively related to the relative amount of R&D expenditures and the relative demands on the defense industry. Other conditions given, defense contractors have been willing to bear greater risk during periods of increased competition. It is not clear that this form of competition is desirable to the government as it involves a higher profit rate, is heavily biased against small firms, and augments the random element in contractor survival.

I

INTRODUCTION

It is widely appreciated that firms subject to long-term contractual relationships, even within highly competitive markets, cannot always be expected to respond to normal economic pressures. Time and its accompanying uncertainty generally require that long-range contracts incorporate considerable flexibility in terms of price, quantity, quality, and so on, and hence these features are altered periodically, either through negotiation or the direct control of one of the parties. Such factors might be ignored in the private sector, where the market may be expected to "remember" and thus to control contract performance through the threat of future reaction. But the contractual relationships between government and industry, although subject to some of the same stabilizing forces, are often of such a long term, and so often modified, that the possibility of undesirable performance (from the point of view of both parties) has aroused a great deal of concern.

One of the most interesting of the many devices which have been used to influence contract performance is the so-called "incentive" clause, which has been appearing with increasing frequency in military procurement and development contracts. In dealing with the most uncertain cost and performance characteristics of research and development efforts, frequent government practice in the past has been to pay its contractors fixed fees based on expected cost and then to pay, ex post, whatever expenses are actually incurred (be they greater or less than anticipated). The use of this "cost-plus-a-fixed-fee" (CPFF) contract has been widely criticized, and has been generally regarded unfavorably by procurement officers as well, because it gives contractors no cost incentive for efficient performance. The fact that actual costs significantly in excess of

estimates are a common experience in CPFF contracts is taken as evidence of their uneconomic character. More recently, increased attempts have been made to induce contractors to share the risks associated with cost performance, by reducing their fees as costs rise above estimates and increasing them as costs fall below. In some cases, firms have been induced to accept "firm-fixed-price" (FFP) contracts in which the contractor absorbs all deviations from projected costs. This type of contract, of course, is just another form of exchanging a specified commodity for a specified price, but calling it FFP underscores the fact that the exchange may involve more than the "ordinary" degree of cost uncertainty for the contractor.

Between the two extremes of CPFF¹ and FFP¹ lie several varieties of cost-sharing, or incentive contracts. Of these, the most familiar, and the one to be given the most attention here, is the fixed-price-incentive-fee (FPIF) contract. Under this type, the government shares all cost underruns with the contractor according to a stated formula, and shares all cost overruns similarly, except that beyond a specified limit, the contractor must absorb all additional costs (i.e., the contract becomes FFP). The only other contract type treated here is the "cost-plus-incentive-fee" (CPIF) contract which, like the FPIF, also provides sharing cost-performance risks according to a specified formula. But it differs from FPIF in two ways: First, it sets maximum and minimum fees, so that outside a certain cost range the contract becomes CPFF; and second, it permits free bonuses and penalty rates to be established on contract performance features other than cost (e.g., date of completion or various product-quality characteristics). Figure I illustrates the cost-fee relationships of simple versions of the four contract types.

The experience with incentive contracts has generally been that cost overruns have been far less frequent and less substantial than

1. Of course, these are not necessarily extremes. There is no logical reason why the government could not pay such a high premium for cost control that contracts concluded with costs below expectations would be more expensive to the buyer than contracts with higher than anticipated costs.

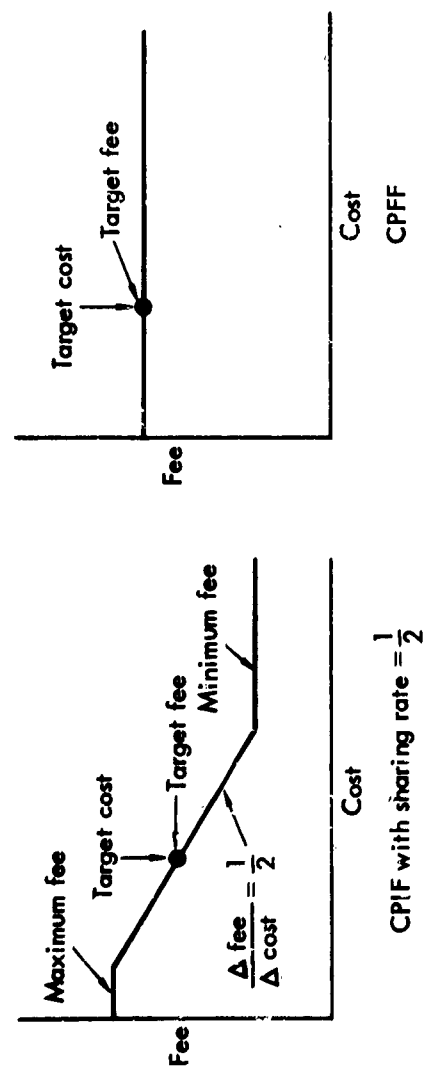
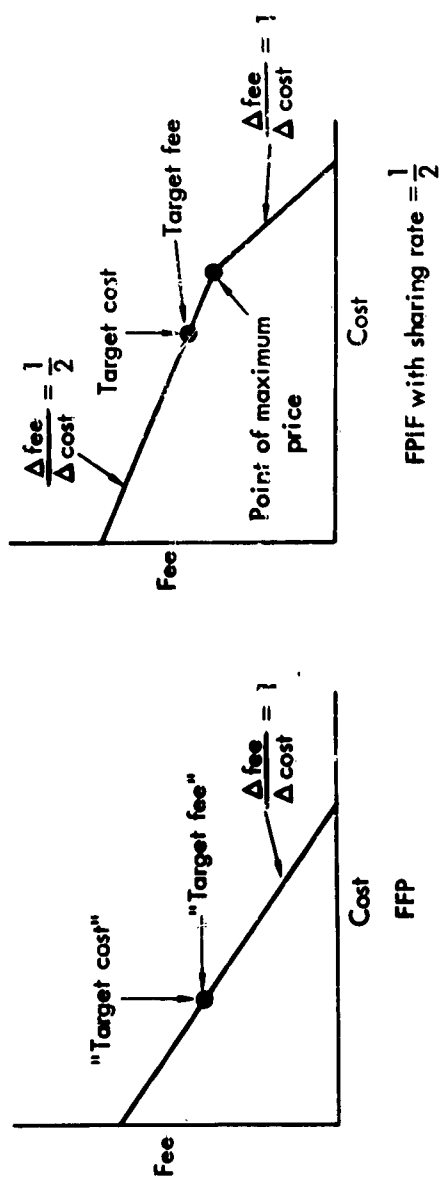


FIGURE 1 Comparison of Four Major Contract Types

with CPFF contracts. This is generally adduced as evidence that the incentive feature of cost sharing works. In fact, Secretary McNamara recently stated to a congressional committee that "for every dollar we can shift from CPFF to ... incentive and fixed-price contracts, we save at least 10 cents."²

In general, this Research Paper is limited to a comparison of CPFF and FPIF contracts. The influences of the performance incentives in CPIF contracts requires separate analysis, although it would be similar in character to that used here. Moreover, due to these other incentive provisions, cost data for CPIF are not strictly comparable to that for FPIF. A second problem not discussed at any great length here relates to the distinction between "initial target costs" and "adjusted target costs." In practice, contracts are modified during performance to take account of changes in product specifications and some cost conditions, and the final "adjusted" target cost may not be fully determined until the project is virtually completed. Nevertheless, it is these costs which are used here as "target" costs. The import of these adjustments will be mentioned where it is relevant, but by and large, "initial target costs" are of little concern for this study.

In principle, the analysis of incentive contracts may appear to be relatively straightforward and to require only an adaptation of the traditional theory of those markets which the incentive clauses are intended to simulate.³ In fact, however, several entirely different approaches to this problem have been used. Current analyses of incentive contracts tend to fall into one of three broad categories as they focus on one of the following dimensions of the problem:

2. Quoted in the Wall Street Journal July 22, 1965. It must be admitted, however, that the author has never encountered documented estimates of dollar savings as large as the quoted ten percent.

3. For an example, see N.S. Weiner, "Multiple Incentive Fee Maximization: An Economic Model," Quarterly Journal of Economics, LXXVII (Nov. 1963).

(1) Risk--the insurance dimension: The use of various cost-fee relationships will influence the extent to which the risk of unanticipated cost overruns (or underruns) is borne by contractor or government. A CPFF contract is, in part, an insurance policy which protects the contractor against overruns. An FFP contract similarly protects the government. The evidence is abundant that both parties are averse to risk bearing and that these considerations are important in the negotiation of contract sharing rates.

(2) The response of performance to cost-fee rates--the incentive dimension: This is the dimension to which traditional market theory may be applied, and, of course, it is this theory in turn which has led to the belief that incentive contracts will lead to more efficient performance.

(3) Negotiation and competitive cost estimation--the foresight dimension: In practice, incentive contracts are negotiated before and even during contract performance. The parameters of the contract (other than basic cost-fee ratios) are rarely stable over time. It is, therefore, of paramount importance to examine the impact of information and anticipations on contract negotiation and the extent to which cost-fee ratios can be substituted for other contract parameters during the bargaining process.

Note that only the second dimension, response of performance, can permit an inference that cost-fee ratios influence efficiency; the others deal with completely unrelated objectives. Yet, it is a remarkable property of this question that, at least for the available data, virtually all the models associated with these dimensions predict the same relationships. On the one hand, as shown later, it is possible to "explain" an observed decline in cost overruns after the introduction of incentives on the basis of any of the three approaches. On the other hand, their premises are rarely the same. For example, models focusing on the incentive dimension generally assume that the firm is given the incentive rates, and that it then proceeds to adjust its performance in such a way as to maximize its profits (or utility);⁴ models constructed with the foresight dimension in mind, assume that the firm knows the outcome

4. This is Weiner's approach, op. cit.

(or at least has an estimate of it) and then negotiates the incentive rates in such a way as to maximize expected returns.⁵ It would still be possible to combine forms of all these hypotheses into one model; but since the objective here is primarily to distinguish among similar phenomena, they will be treated separately. The significance of the problem arises from the fact already noted that not all these theories include efficient contract performance among their consequences, although all of them can show that incentive contracts are associated with a lower incidence of overruns than are CPFF contracts. Thus, in the following separate treatments of these dimensions of the contracting problem, the conclusion that incentive (or FFP) contracts reduce the incidence of overruns below that associated with CPFF contracts is emphasized each time it appears.

A major difficulty in an analysis such as this derives from the fact that incentive and CPFF contracts, by their very natures, deal with projects which are subject to considerable cost uncertainty. Thus the most important class of variables (i.e., costs or product quality) are subject to such high variances that only the most broad use can ever be made of them. Statistical significance, once contract costs are introduced, is a rare result indeed. Furthermore, with the rather limited data at hand this analysis must be confined to only a few major variables: the initial fee given to the contractor, calculated as a percentage of estimated ("target") cost; the sharing rate measuring the proportion of cost deviations from target to be absorbed by the contractor; the final cost of the contract; the contract type; and the contract size. Four sets of data are used in this study:

- (1) relatively detailed information on 60 incentive contracts and 93 CPFF contracts, all with final costs exceeding one million dollars and all completed in calendar year 1964 for the Air Force;
- (2) summary data for 22 incentive contracts and 668 CPFF contracts, all with final costs less than one million dollars and all completed in 1964 for the Air Force;

5. This approach is used by F.M. Scherer: "The Theory of Contractual Incentives for Efficiency," Quarterly Journal of Economics, LXXVIII (May 1964), pp.257-280.

- (3) summary data for 371 incentive contracts and 1526 CPFF contracts involving over one million dollars each, closed over the six year period from 1959-1964 (all for the Air Force); and
- (4) summary data giving the total Defense Department use of various contract types from 1953 to 1965.

II

PARAMETERS OF INCENTIVE CONTRACTS

By definition, the outcome of an FPIF contract under which fee is varied only with cost, may be described by the formula

$$F = \pi C_T + \alpha(C_T - C),$$

which is more conveniently rewritten

$$F = (\pi + \alpha)C_T - \alpha C,$$

where

F = the contractor's final fee;

C_T = the "target" cost written into the contract;

C = final contract cost upon completion;

π = the profit written into the contract, expressed as a percentage of target cost; and

α = the contract sharing ratio, giving the extent to which fee is changed as cost changes--i.e., the slope of the cost/fee line in Figure 1 ($\alpha = 0$ characterizes a CPFF contract, $1 > \alpha > 0$ an incentive contract, and $\alpha = 1$ an FFP contract).

Both C and C_T are exclusive of fee. Hence the target price to the government is given by $C_T (1 + \pi)$, and the final contract price equals $C + F$ or $(\pi + \alpha)C_T + (1 - \alpha)C$.

In practice, although costs are calculated exclusive of "profit", a number of what would normally be treated as fixed costs to the firm (such as most overhead items) are included. This addition of overhead to costs can cause an enormous amount of difficulty in contracting all by itself. It creates an incentive for the contractor to transfer overhead to any CPFF contracts it may be fortunate enough to hold, which, to be controlled, would require intensive policing action on the part of the government contract officers. Furthermore, this

same feature can dissipate to a great extent the cost-sharing ratios of incentive contracts. To take an example of this, it is not uncommon for weapons system manufacturers to "stockpile" engineers, individuals who are largely unproductive if not on any contract. Suppose that by adding some new sophistication to the product the contractor could utilize these engineers. Letting the cost of the engineers over the time of the contract be D dollars, and the total cost of the additional development be T dollars, then the net cost to the contractor is $(\alpha T - D)$ and a cost sharing rate is $(\alpha - \frac{D}{T})$. If the development makes use of a high proportion of engineering time, that is, if $\frac{D}{T}$ is larger than α , the net cost to the contractor is negative just as in the CPFF case. Even if $\frac{D}{T}$ is not large, the effective cost-sharing ratio is less than α . It is impractical to prevent firms from shifting costs in this way: to do so, contracting officers would have to manage projects themselves, destroying the whole purpose of contracting the work out in the first place. It would be well to bear in mind two consequences of this point. First, contractors holding both CPFF and incentive or FFP contracts will tend to transfer costs to the CPFF work: insofar as this takes place after cost estimates are made, there will be a tendency for CPFF contracts to display a higher incidence of overruns than other contract types. Second, the effective sharing rates on incentive contracts are probably significantly lower than those explicitly written into them.

Not only is overhead added to cost, but fee is calculated as a percentage of total costs. Recently, some efforts have been made to remedy this by modifying profit computations to take account of the magnitude of the requirements on the firm's own resources. Nevertheless, it is still generally true that contract profit percentages do not reflect any such variable. Thus π , although subject to negotiation and modification, does not give any measure of the rate of return on the manufacturer's capital. These weaknesses in the calculation of the firm's return can themselves lead to serious inefficiencies in contractor performance; but as they are not of direct relevance to the incentive problem, they are disregarded hereafter.

III

THE INSURANCE DIMENSION

A. RISK

Basic to the contracting process is the problem of risk-bearing. The reason for issuing any contract form other than FFP is that development costs are so uncertain as to make possible enormous errors in estimation: a perfectly plausible cost overrun in a development contract, for example, could amount to 25 percent or more of the net worth of a firm holding it. If contracting firms had no aversion to such risks, of course, FFP would still be appropriate, with no change in the expected fee rate. In practice, however, in order to induce firms to accept the risks inherent in such projects, the government apparently would have to pay much higher (expected) profits than it cares to do: it would much prefer to absorb the risk itself, paying the contractor only such fees as are necessary to divert its resources to the job. This is by no means unreasonable. Despite the traditional interpretation of the firm as a risk-bearer, the government, through its great size, is far more able to pool the risks of many projects. It would be pointless to pay contractors for a service (risk-bearing) which the government can provide for itself at virtually no cost. Unfortunately this point does not extend to the individual military procurement officer, to whom unexpected contract cost overruns may appear to reflect upon his own performance, and compromise his career. Thus the government may be expected to behave as though it, too, had a strong aversion to risk, and hence a preference for even relatively expensive insurance policies. This is simply another example of a large organization failing to transmit its own incentives and values to those who administer its policies. Risk-aversion by persons who represent the military can easily distort an otherwise efficient

system and it is to be feared that contractual incentive rates are heavily influenced by this factor.

A model constructed from the insurance dimension of the contracting process alone would be expected to generate conclusions such as the following:

- (1) Risk considerations do not appear to explain fully the observed tendency for CPFF contracts to cost more than expected.

There is no reason why firms should not formulate neutral (i.e., maximum likelihood) estimates of contract cost so long as all contract risk rests on the government. This conclusion must have one qualification: It has been pointed out that the government, in selecting contractors whose projected costs are lowest, would tend to select those firms which had underestimated their costs. It would appear, however, that through a learning process, both contractors and the government would come to appreciate such biases and take them into account in their estimates. Thus little, if any, downward bias in cost estimates would be expected, and hence little tendency toward cost overruns.

- (2) Small firms would shy away from risk-bearing contracts even more than large ones, being less able to bear the cost of uncertainty.

"Risk" will always be measured by a contractor in some inverse relation to his own size. The relevant variable for measuring observed risk would presumably be of the form

$$\frac{\sigma_c^2}{S^2},$$

where σ_c^2 is the variance of cost and S is some measure of the net worth of the firm. Thus firms with small S would tend to see contract risk magnified, and they would take on commensurably smaller projects, would avoid research and development altogether, or would attempt to transfer risk to the government even more heavily than larger firms, showing a higher incidence of CPFF contracts. There is considerable

evidence that the second of these predominates, and that smaller firms do in fact avoid uncertain projects. Table 1 gives the percentage of total procurement from business in general which was let out to small business firms (as defined by the Small Business Administration) from 1957-1964, and compares that percentage with similar figures for "experimental, developmental, test and research" work. It is apparent that small firms participate far less in R and D business. The contrast is made even more striking by the fact that of the development work--where costs are probably the most uncertain--only 2.8 percent went to small business. These percentages are calculated on the basis of all work given to businesses; if total procurements are considered the percentages fall even lower. It might be argued that this bias can be explained by observing that the data deal only with prime contracts and that most projects with uncertain costs are, in reality, very large ones which are beyond the capability of smaller firms (i.e., the small firms participate in the R and D work only through subcontracts). It is unclear, however, why research and development should require, a priori, such a high proportion of large contracts; it is a much more plausible hypothesis that the disinterest of small firms in R and D has simply made it convenient to give to large firms contracts which represent aggregations of smaller (but related) projects.

(3) So long as most firms do possess the observed aversion to risk-bearing, there should be, if other things are equal, a general tendency toward pure CPFF contracts.

If a large number of contracts do have a sharing rate greater than 0, then this is the case for reasons other than risk. Sharing rate (α) would not be expected to measure reliably the cost uncertainty of a contract, at least not until whatever other variables are responsible for $\alpha > 0$ are quantified and introduced. Traditionally, all unusual risk has been shifted to the government. In 1960 fully 38 percent of all procurement (in dollar terms) was under CPFF while only about 17 percent was in incentive contracts. More recently these two figures have moved to 12 percent and 33 percent respectively and, according

Table 1
DEFENSE DEPARTMENT PROCUREMENT FROM ALL US BUSINESS AND FROM SMALL BUSINESS^a
(Thousands of Dollars)

	1957	1958	1959	1960	1961	1962	1963	1964
Total DoD Procurement from Business in General	21,458	24,197	25,312	23,689	25,584	29,254	29,379	28,796
DoD Procurement from Small Business	3,783	3,729	3,783	3,440	3,657	4,622	4,301	4,519
Small Business as a Percent of Total Business	19.8	17.1	16.6	16.1	15.9	17.7	15.8	17.2
Experimental, Developmental, Test, and Research from All Business	3,256	4,031	5,239	5,551	6,023	6,096	6,213	5,767
Experimental, Developmental, Test, and Research from Small Business	131	139	170	180	161	197	198	190
Small Business as a Percent of Total	4.3	3.7	3.5	3.4	2.9	3.5	3.5	3.7

a. Source: Military Prime Contract Awards and Subcontract Payments or Commitments, O.S.D.

to the Department of Defense, this increase in the proportion of incentive contracts is due to a deliberate effort to increase contract sharing rates. Thus the force responsible for higher α may simply be the buyer's desire to move toward more incentive contracting, and the value of α may reflect, to a considerable degree, the buyer's economic power relationship with the contractor.

(4) If, in fact, a sharing rate other than zero should arise, the profit rate should be expected to increase--that is, as risk is transferred to the contractor, his profit rate, other things being equal, would have to be increased accordingly.

In fact high sharing rates do lead to increases in fee. Historically (1959-1964), fee rates on CPFF contracts have averaged 5.7 percent while those on incentive contracts with an average sharing rate of about .20 had an average fee rate of 8.2 percent.⁶ Thus the historical relationship between α and π has given a slope of

$$\frac{\Delta\pi}{\Delta\alpha} = \frac{2.5}{20} = .125$$

in the relevant range of FPIF contracts. This implied price for risk-bearing is, in fact, quite high, suggesting that if the firm were to absorb it all, it would charge about 12.5 percent of expected cost just to bear the risk. (Occasionally, the entire risk is absorbed by the contractor, yielding rates of return--risk plus normal return on capital--of 15 percent or more.) Given this relationship, one is struck by the fact that an analysis of FPIF contracts with sharing ratios varying from about 3 percent to 50 percent show no trace of this positive price for risk-bearing.⁷ Thus, although various classes of contracts do show such a price, it vanishes in intraclass comparisons. The implications of this phenomenon are discussed in the next section.

6. The averages are influenced by contract size: the 8.2 percent figure given above represents the actual dollar cost to the government for all the contracts closed in 1964. The unweighted average profit is somewhat higher at 9.08 percent.

7. In fact, a least-squares fit of π against α for a sample of 41 contracts gave a negative slope (although the coefficient is not significantly different from zero).

(5) Development projects vary widely in their degree of cost uncertainty, and thus in the amount of risk a firm would assume by accepting a cost-sharing contract.

Such contract forms should, therefore, be applied most easily to the less uncertain projects--that is, the variance of cost deviations from expectations would tend to be smaller for incentive than for CPFF contracts.

B. PRICE AND RISK COMPETITION

In the past, the market for military products has varied widely in its competitive atmosphere. During the early 1960's military research and development procurements fell relative to their remarkably constant rate of growth during the 1950's and a noticeable degree of competition crept into areas involving even very small numbers of firms. Government buyers found it quite easy to induce the industry to take on additional economic burdens. In this Research Paper, we will concentrate on only two such variables, disregarding others, which, although perhaps quite important to the industry-government relationship, are less relevant to the contracting process itself.

Price competition has its place among defense contractors just as it does everywhere else, although it takes a form which appears to be somewhat unexpected by the buyer. As mentioned earlier, "profit" is explicitly calculated in military contracts, appearing as some percentage of target cost; so that the total target price to the government equals $(1 + \pi)C_T$. Now when the government chooses among competing sellers, it does not choose the one which offers the lowest π , but rather the one which offers the lowest total price. Imagine a firm which wishes to reduce its bid for a CPFF contract, and suppose that the initial terms were $\pi = 6$ percent and $C_T = \$1$ million. The firm may reduce the expected return to itself by \$10,000 either (a) by reducing π to 5 percent, in which case total target price is reduced from \$1,060,000 to \$1,050,000, or (b) by reducing C_T to \$883,333. Both contracts would yield the same return to the contractor,

but one quotes a much lower price. Naturally, then, target cost becomes the competitive variable, and π simply assumes any convenient value. This point of view is given considerable support by the remarkable constancy of profit ratios within contract classes and over considerable periods of time. The same analysis holds for incentive contracts (i.e., $0 > \alpha > 1$). In this case, adjustment of C_T has an impact on profits through π and through the sharing ratio as well. Expected fee now is given by the expression $\pi C_T + \alpha(C_T - C)$ so that a reduction in target cost, ΔC_T , reduces expected profits by the amount $(\pi + \alpha)\Delta C_T$. I know of no case, however, where the expression $(\pi + \alpha)$ has been greater than about 0.6, from which it follows that adjustment in C_T is still the more effective way for a contractor to cut his price.⁸ Note further that such behavior will lead to the overruns so commonly experienced. The buyer, moreover, has no defense against such adjustments in C_T unless he can himself estimate costs with the same degree of accuracy as the firm.

It was pointed out in the previous section that risk considerations would lead one to expect higher profit rates to accompany higher sharing rates, and yet, although this was confirmed by comparing entire contract classes, no such relationship could be obtained within a single class sample. If in fact C_T is the profit adjustment variable, then increases in α would lead to increases in C_T . Naturally, this would tend to reduce the possibility of contract overruns. Thus we again obtain the conclusion that within each contract class high sharing rates should lead to a reduced incidence of overruns.

8. This position that C_T is in fact the common price variable, is given further support by the frequent observation that π appears to have a special significance for procurement officers (see, for example, Arthur D. Little, Inc., How Sick is the Defense Industry?, Report C-57904-51; fourth printing, September 10, 1963) who are often willing to expend enormous energy to induce contractors to accept a desired π rate--even when the resulting difference in fee amounts to only a few dollars. π may thus become almost a non-negotiable parameter of the contract compared to the ease of making adjustments in C_T .

There is a second dimension in which contractors may compete with one another: that is, the absorption of risk. The buyer has always shown some preference for FFP contracts, and although contract type is usually specified by the government before any bids are taken in, a contractor who offers a more stringent one has a considerable advantage over his fellows. During a period of relatively stiff competition, the government may be able to require a greatly increased level of risk-bearing on the part of the seller. This interpretation would imply that the 1961-65 upsurge of incentive and CPFF modes was in part a consequence of a well-publicized increase in competition as well as increased procurement sophistication.

This hypothesis was tested with the following simple model. Three variables are relevant: time (to reflect growing awareness on the part of procurement officers of the importance of cost-sharing), research and development expenditures (since these are the primary sources of risk-bearing contracts in the first place), and the overall level of defense procurement (to reflect the level of demand and hence roughly the competitive pressures in the industry--at least in those sectors of the industry which have limited private sector alternatives). An inspection of procurement data over the last few years yields a clear impression that from the end of the Korean War to 1960, Defense Department R&D expenditures rose at a relatively constant rate, but that after 1960 they fell off from this trend and remained relatively stable. This leads to the conclusion that the increase in competitiveness in the industry during the early 1960's is due not to a net reduction in demand but simply to a failure of demand to continue growing. Thus, as an index of competitive pressure, we used the deviation of procurement from the 1954-1960 trend.⁹

The results of the linear regressions are listed in Table 2. The dependent variables are percentages of total procurement (in dollars) allocated to each contract type.

9. The dates of the trend are not critical: the results of the model are not seriously altered even if a 1954-65 trend is used. The 1954-60 period is used here primarily because it conforms to the original hypothesis which was proposed. (See Military Prime Contract Awards and Subcontract Payments or Commitments, Office of the Secretary of Defense, various issues.)

Table 2

DETERMINANTS OF FREQUENCY OF CONTRACT TYPE

Contract Type	Regression Results ^a				
	Constant Term	Deviation in Total Procurement	Portion of Total in R&D	Time	R ²
FFP	48.83 (3.71)	- 1.348 (.38)	- 1.077 (.27)	+ 1.274 (.437)	.91
FPIF	32.18 (3.327)	- .2714 (.3402)	- .6876 (.2450)	- .2697 (.3919)	.80
CPIF	5.493 (3.446)	- .1492 (.3524)	- .4991 (.2538)	1.424 (.4060)	.82
CPFF	.2010 (5.287)	1.316 (.5906)	2.058 (.3894)	- 1.989 (.6228)	.90

a. Standard errors in parentheses.

The figures beneath the coefficients are the standard error of the estimate. Note that although the four contract types together have always amounted to about 90 percent of total procurement, other, minor contract types have varied enough to prevent the coefficient of each independent variable summed over the four independent variables from equalling exactly zero. A number of observations may be made from these relationships.

- (1) Competitive pressures appear to play a significant part in the degree of risk absorbed by contractors.

As overall procurement rises above the trend, FFP contracts decline in frequency while CPFF contracts become more common. The two influences of this variable on the intermediate contract types can not be determined significantly--presumably because contracts which are shifted from FFP into these categories are roughly balanced by others shifted from intermediate types into CPFF.

- (2) These relationships support the thesis that risk tends to shift contracts all the way to CPFF.

In contrast to the procurement variable, which appears simply to shift all contracts up or down a notch, research and development expenditures reduce the proportions of all other contract types in favor of CPFF to a degree which is significant both statistically and practically.

(3) The importance of the time variable indicates that there has been a secular trend in the frequency of certain contract types, especially in the case of the CPIF contract.¹⁰

This, of course, is simply a reflection of the current interest in incentive contracting.

In general, then, it appears that growing interest in cost-sharing contracts as well as a growing aversion to CPFF contracts on the part of the Department of Defense have been partly responsible for the recent shift in contract type proportions, but they have been greatly assisted by the fact that contractors have been using risk-absorption as well as prices as means of competition for business.

It is less clear, however, whether this form of competition is desirable. Risk absorption by contractors has two important disadvantages. First, it has a price, involving an increase of about 2.5 percent in costs just to get a firm to move from CPFF to FPIF with a sharing rate of about .20 (or, instead of contracting FPIF, the buyer could get a price reduction of 2.5% by moving to CPFF). Second, it does not possess the highly desirable property of price competition that it will be only the relatively inefficient firms which are put out of the industry--risk absorption, although still favoring the efficient, introduces an element of randomness into contractor survival. Furthermore, risk competition is heavily biased against smaller firms, to whom, as mentioned earlier, a given cost variance represents a much larger risk than is the case for large firms. Thus the government's efforts to increase cost-sharing has probably contributed to the very low participation of small firms in military

10. It might be suggested that CPIF contracts have become popular recently precisely because of their capability to reduce contract risk. This is the only incentive contract type which permits flexibility in product performance, and hence, in the face of technological as well as cost uncertainty, these contain far less risk than the more common FPIF contract.

development efforts on prime contracts. The buyer, who is without any need for insurance, apparently is permitting its contractors to compete in the offering of insurance rather than the reduction of fees. Such inefficient behavior would form a powerful inducement to discourage risk-competition in favor of price competition were it not for the incentive arguments which are presented in the following section.

IV

THE INCENTIVE DIMENSION

As pointed out earlier, the CPFF contract gives the contractor no explicit inducement to control costs, and this is commonly taken to be the cause of the observed penchant of CPFF projects for cost overruns. In a sense, a cost-sharing contract may be interpreted as a combination of two elements: a basic CPFF or risk-sharing contract and a separate arrangement which pays the contractor a fee in return for cost cutting efforts. The contractor is selling efficiency to the buyer. Unfortunately, the sale cannot possibly take place without shifting some risk onto the contractor, and for this, as shown above, he must be paid a higher fee. A few important problems and characteristics related to the incentive dimension alone are outlined in this section.

The relationship between estimated cost for an incentive contract and for the same project on a CPFF basis is uncertain. If the firm took full account of the impact of the incentive fee on its own operation, its cost estimates would be lower, and the tendency toward overruns and underruns would be no different from the pure CPFF case. This does not mean that the incentive contract would be of no net benefit to the firm or to the government: the contractor would gain from the more efficient use of its own resources, and the government, of course, from the lower price. It is usually assumed, however, that the contractor takes no account of his potential behavior when negotiating the incentive agreement, in which case, the cost estimate would be the same as for the CPFF contract. Various observers of the contract negotiation process have indicated that

this latter assumption is the more realistic, and in fact Scherer¹¹ has observed C_T to increase as contracts were shifted toward higher cost sharing during bargaining sessions. (Such increases would be consistent with the analysis of risk in the last section.) However, it is still conceivable that even a complete failure of incentive contracts to show a higher incidence of cost underruns would not completely reject the hypothesis that the contracts are in fact being performed more cheaply.

It also should be noted that considering only the incentive aspect of the problem, the firm would prefer high sharing rates to low ones--that is, high prices paid for its efforts at cost-cutting. A firm might even be found that was willing to sacrifice some profit on the basic contract in return for an increase in α , so long as its cost estimates were unbiased and it suffered from no risk-aversion whatever. If this were the case, contracts should show a tendency toward lower target profit (lower π or higher C_T) as α is increased.¹²

Cost sharing actually may be expected to influence two aspects of the firm's operations. Besides inducing more efficient operations, it is likely to have a substantial incentive impact upon purely accounting practices. For example, as mentioned in Section I, this analysis disregards the fact that overruns and underruns are not measured from initial target costs but from "adjusted target costs"--that is, target cost estimates made after taking into account all the changes and modifications which the government has authorized (at a cost) during performance of the contract. Note here that when a contract contains a high sharing rate, the contractor has a much

11. Frederic M. Scherer, The Weapons System Acquisition Process, Harvard University Press, Boston (1963).

12. In fact, if profits are adjusted through C_T as we suggest, increases in α might actually reduce the observed magnitude of under-runs and increase overruns. This tendency is just the opposite of that expected from risk considerations and is in fact the reverse of the tendency expected by those who use the opposite slope to justify the use of incentive contracts in the first place (i.e., they disregard the possible variation in C_T).

stronger inducement to be certain that all possible extra cost items are in fact included in the adjusted costs, rather than to let them appear as overruns. Thus we would again expect high sharing rates to accompany increased underruns and reduced overruns.¹³ Another incentive effect upon accounting departments stems from the risk dimension itself: one way of reducing contract risk is to make more careful cost estimates. Thus cost sharing contracts will be likely to result in substantially smaller variance in cost performance; and the larger the sharing rate, α , the less will be the extent of both overruns and underruns.

13. McCall has given support to this hypothesis with data which show that for contracts with $.025 < \alpha < .15$, 52 percent of the increases in final costs over initial target costs are included in adjusted costs, while for contracts with $.25 < \alpha < .50$ this figure rises to 143 percent (i.e., the contracts showed underruns). Unfortunately, however, as the reader may ascertain for himself, several other hypotheses presented in this paper predict the same relationships in the data.

V

THE FORESIGHT DIMENSION

It has been suggested in earlier sections that frequently contractors are aware of and deliberately introduce target costs which are significantly different from their expectations; this is a consequence of the view that C_T is largely used as a price variable rather than as an estimate of final costs. A corollary of this proposition is that contractors can predict to some extent the occurrence of overruns and underruns. Although this ability stands in direct contradiction to the assumptions of many studies, it is undeniable that it is often present and that it has a strong influence during the negotiation of sharing rates. When a contractor virtually insists on an incentive rather than a CPFF contract, there is a strong presumption that he does not anticipate an overrun. It is ironic that underruns occurring on these same projects (e.g., the "VELA" nuclear detection satellite constructed by TRW) are often widely advertised as demonstrations of the effective cost control yielded by incentive contracting. A number of hypotheses may be constructed which rest entirely on the relationship between foresight and the negotiation of sharing rates, disregarding both risk and incentive problems. A few of these are condensed in the following paragraphs.

The first hypothesis is the simplest and, in fact, the most plausible: the contractor will attempt to negotiate sharing rates which are most beneficial to him in the light of his expectations. If the contractor expects an overrun, he will try for a low sharing rate. If the buyer is adamant in demanding higher sharing rates, the contractor will attempt to reduce the anticipated overrun by negotiating for a higher target cost (competitive pressures, of course, may preclude much variation of this sort). In either case, if the contractor

expects to have an overrun there will be a tendency for smaller overruns to be associated with higher sharing rates. If the contractor expects an underrun, the analysis is reversed, and he will attempt to negotiate higher sharing rates. (Risk considerations, however, will prevent him from wanting to go all the way to FFP.) Thus, if the contractor expects to achieve an underrun, there will be a tendency for larger underruns to be associated with higher sharing rates.

The bargaining element in military contracting has some other interesting properties. After proposing a very rough contract and inviting competitive bids, the government selects a contractor and then negotiates all the final contract details, not even excluding performance parameters of the product. Incentive contracts have a potential for simplifying these negotiations enormously. Suppose, for example, that the government makes (or wishes for its own reasons to advertise to the public) a cost estimate significantly below that of the contractor. If the firm is willing to work for any rate of return less than that offered, some cost estimate C_T and sharing rate can be discovered such that the contract contains both of their expectations. For example, in Figure 2, the point A represents the expected cost and desired fee of the contractor, while point B represents the same for the buyer. Despite the dissimilarity of these positions, an FPIF contract exists (such as that given by the line CDE) which satisfies them both. On this interpretation, incentive contracts serve to simplify the negotiation process, permitting two parties to form an agreement despite widely differing positions. Other things being equal, the larger the difference between the two estimates, the smaller the sharing ratio. That is, the sharing ratio and the extent of overruns would be expected to be negatively related. Conversely, if C_T should happen to exceed the contractor's estimate (a rather unlikely event in the terms of this theory), the firm would receive constant profits if the sharing ratio and the extent of underruns were negatively related.

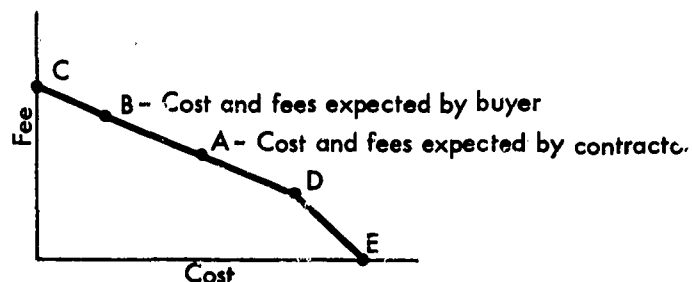


FIGURE 2 Reconciliation of Expectations
Through the FPIF Contract

A third interesting theory may be constructed within the foresight dimension to analyze the impact of variations in relative contractor efficiency. Suppose that all potential contractors have alternative uses of their plant and equipment in the private sector and that the profit which they demand reflects these alternatives. Further, assume that the government does offer a fixed profit rate π on all contracts of a given type. One would expect the more efficient firms to demand higher profits on government contracts than would the less efficient firms. In the case of CPFF contracts, the inefficient firms could always underbid the more efficient because they would be willing to settle for a lower fee (πC_T). In the case of cost-sharing contracts, efficient firms would win the contracts because their potential for underruns would increase their expected fee while overruns would penalize the inefficient. Thus we would expect increases in sharing rate α to result not only in more efficient firms winning contracts, but also in a reduced incidence of overruns and an increased incidence of underruns.¹⁴

14. This theory is presented in J. J. McCall, An Analysis of Military Procurement Policies, RAND Memorandum PR RM-4062-PR, Nov. 1964.

VI

EXAMINATION OF THE DATA

It will be useful to summarize the foregoing "explanations" before examining the data. A rather unexpected development of this analysis was the necessity to distinguish the effects of incentives on overruns from those on underruns. This need arose from the attempt to account for the possibility that C_T is not simply an estimator of project costs, but an integral element of contract competition and negotiation. Naturally, contracts which are observed to overrun would not correspond precisely to those which were expected to overrun. Nevertheless, the best that can be done is to divide the sample of contracts into those with overruns and those with underruns and hope that the basic variance in cost has not completely diluted the results.

No less than eight independent explanations have been identified for the observed tendency for higher sharing ratios to be associated with reduced overruns:

- (1) The inclusion of fixed (overhead) costs in basic contract costs tends to induce the contractor to shift overhead from high to low sharing-rate contracts.
- (2) It is easier to induce firms to accept high sharing rates in less risky contracts--i.e. those containing relatively small overruns in the distribution of possible outcomes.
- (3) If firms do accept high risk in contracts, they will tend to "charge" for it, increasing C_T , and reducing the extent of overruns.
- (4) High sharing rates give contractors an incentive to put all possible cost increases into the "adjusted cost" category, rather than permitting them to result in overruns.
- (5) If the α , C_T combination was chosen primarily to reconcile a divergence of expectations between contractor and buyer, high sharing-rates would be possible only if the difference of opinion were small--i.e. if the expected overrun were small.

(6) If contractors anticipate the extent of overruns and underruns, they will attempt to negotiate sharing rates which will maximize their own expected return, increasing α as the magnitude of expected underruns rises.

(7) Relatively inefficient contractors would be most willing to make low bids on contracts with low cost sharing ratios--increases in α would result in contract awards to more efficient contractors, resulting in reduced overruns, and increased underruns.

(8) High sharing rates give contractors an incentive to perform the contract efficiently, and to control costs.

For underrun contracts, the conclusions are generally similar, i.e., most of the eight explanations above would account for increased underruns. However, for the following two hypotheses, a high sharing rate would result in reduced underruns.

(9) If the α , C_p combination was chosen primarily to reconcile a divergence of expectations, large values for α would accompany relatively small expected underruns.

(10) Since contractors are more likely to accept contracts with high- α if the risk is low (i.e., if the variance in the cost estimate is low), high sharing rates may well accompany a reduced incidence of large underruns.

Of all of these, only two hypotheses imply that the use of contractual incentives is of economic benefit to the buyer: number 7 because it suggests that they influence contractor selection (although this could be done just as well with other devices--see the last section), and number 8 which suggests that incentives influence contractor performance. It certainly would be premature to conclude that a negative sharing rate-overrun relationship justified the use of incentive contracts.

The expected reduction in overruns as α is increased is generally confirmed, subject to some reservations. The sample of 43 FPIF contracts used for the analysis is small enough so that one contract with a 50 percent sharing rate and a very high overrun actually reverses the sign of the slope. Since this point, however, is several standard deviations from the rest of the data, it was thought justifiable to delete it. Using the symbol C to represent final costs, the relationship for overruns alone was:

$$\frac{C}{C_T} = 1.057 - .052 \alpha$$

(.040)

$$R^2 = .60$$

The number in parenthesis is the standard error of the estimate. The sign of the coefficient is significant at the 5 percent level. In the case of underruns, as we might expect from our discussions, the relationship is more ambiguous:

$$\frac{C}{C_T} = .87 + .23 \alpha$$

(.26)

$$R^2 = .20$$

Note that this implies that as the sharing rate is increased, the extent of underruns is decreased. The sign of the coefficient is not significant at the 5 percent level, but it is significantly different from the coefficient for the overrun data.

These data lead to a conclusion that in the case of underrun contracts, at least one of the two hypotheses (9 or 10) is operating so strongly as to determine the sign of the slope. The most plausible of these is probably number 10; high sharing rates are much more likely to appear on those projects with the less uncertain costs. This same relationship, of course, is reflected in the variance of the overrun/underrun data. For example, the standard deviation of cost data was equal to 25.9 percent of estimated costs for a set of 93 CPFF contracts (over \$1 million), while for a comparable set of 43 FPIF contracts, the standard deviation was 11.2 percent of estimated costs. (This point, unfortunately, weakens our statistical results by suggesting that the distribution may not be normal.)

The crucial question now is to what extent target costs are affected by other contract parameters. Insofar as they are affected, the empirical case for incentives is weakened. As it happens, there is one more means at hand for determining the variability of C_T which may be added to previously mentioned evidence. From the point of view of the incentive theory, there is no reason to expect any relation between target fee and the extent of cost overruns, since it is the rate of change of fee and not fee itself which is supposed

to create the inducement toward efficiency. If C_T is negotiable, however, such a relationship would be expected. It has already been pointed out that the return to the firm may be increased through increases in π and/or increases in C_T . Normally, adjustments would be expected through both of these, and thus, in general, π would be expected to be negatively related to the extent of overruns. This hypothesis is supported, albeit very weakly, by the data. In the case of overruns:¹⁵

$$\frac{C}{C_T} = 1.575 - 5.44 \pi \quad R^2 = .34$$

(2.33)

This result suggests that some part of the observed decline in overruns may be due to adjustments in target costs. These figures must not be taken too seriously: one must bear in mind that the data are of uniformly low quality for our purposes (ex post $\frac{C}{C_T}$ may be quite different from expected $\frac{C}{C_T}$) and the variance of π within one contract type is extremely low as well (see section III). Moreover, the result is not confirmed significantly by the underrun data.

However, even if the above evidence is disregarded and only insurance costs are taken into account, the case for incentive contracts turns out to be shaky. Suppose that we accept the proposition that cost overruns are reduced solely by the incentive effects of high sharing rates, and disregard the possibility that C_T itself is being used as a negotiated variable.^o Further, suppose that contracts chosen for FPIF are no more risky than those left under CPFF. Under such assumptions, the proper estimate of the savings received from an incentive contract is given by (1) the average percentage overrun experienced under CPFF contracts minus the sum of, (2) the average percentage overrun experienced under incentive contracts (this figure is negative for underruns), (3) any extra profit earned by the contractor for his underrun (negative for overrun), and (4) the profit

15. The case of underruns is similar but not at all significant:

$$\frac{C}{C_T} = .973 - .42 \pi \quad R^2 = .08$$

(.94)

differential which was necessary to induce the contractor to accept an incentive contract in the first place. It is amazing how frequently this last term is neglected, despite its ease of calculation. As mentioned in Section III, historically, the government has had to pay a sum equal to about 2.5 percent of projected costs to induce the contractor to move from CPFF to FPIF with a sharing rate of .20. Table 3 contains some average values for these figures for various years and contracts. All entries are calculated as percentages of adjusted target cost. The final column contains the net "saving," (item 1 minus items 2, 3, and 4 above) which can be attributed to FPIF contracts, calculated as a percentage of target cost. The evidence indicates that the net saving from the use of incentive contracts has fallen over time, with those closed in 1964 actually showing a loss to the government! Certainly there is nothing approaching the widely advertised 10-percent savings from the use of incentive contracts.

Moreover, this estimate of net savings, being dependent upon the assumption that C_T is not a negotiable variable, is surely biased upward. If C_T is variable, as the evidence indicates that it is, the savings to the buyer are commensurably reduced. Furthermore, the downward trend in the "net savings" figure might be explained in terms of C_T and the increased level of competition which has been observed in recent years. That is, as firms reduced their "prices" they reduced contract target costs, rather than π and hence reduced the proportion of underruns.

Table 3

CALCULATION OF ESTIMATED SAVINGS FROM TRANSFER OF
CONTRACTS FROM CPFF TO INCENTIVE^a

Description of Contract	Contract Type	Number of Contracts	Adjusted Target Cost, \$	Final Cost, \$	Percent Overrun	Profit, % of Cost, \$	Saving, % of Target Cost ^b
1959-64 (6 yrs); All AF Over \$1 million	CPFF Incentive	1,526 371	4,335,000 8,656,000	4,541,000 8,498,000	4.5 -1.8	5.7 8.5	+3.5
1959-63 (5 yrs); All AF Over \$1 million	CPFF Incentive	1,433 311	3,451,000 7,237,000	3,625,000 6,996,000	5.0 -3.3	5.7 8.7	+5.3
1963; All AF Over \$1 million	CPFF Incentive	81 68	935,000 1,764,000	950,000 1,713,000	1.7 -2.9	5.8 8.5	+1.9
1964; All AF Over \$1 million	CPFF Incentive	93 60	884,629 1,418,632	916,126 1,501,844	3.6 5.9	5.7 8.4	-5.0
Excluding Rep. Aviation ^c	CPFF Incentive	59	1,209,224	1,210,524	0.1	9.2	0.0
1964; All AF Under \$1 million	CPFF Incentive	668 22	98,749 9,840	95,810 9,801	-3.0 -0.4	6.4 8.3	-4.5

a. Unfortunately, the data here have been aggregated, and include some CPFF as well as FPFF contracts. The great majority, however, are FPFF.

b. Calculated as % overrun (CPFF) - % overrun (Incentive + % Profit (CPFF) - % Profit (incentive)).

c. This single contract, a large CPFF with an enormous overrun, was singled out for possible exclusion by the agency reporting the data, although it is apparently chosen only for reason of the large overrun.

VII

CONCLUSION

This has proven to be a rather skeptical study of the usefulness of the cost incentive device in contracting. In summary, it ~~has~~ suggested that the introduction of cost-sharing necessitates a payment for risk-bearing which in recent years has exceeded any savings which are obtained from increased efficiency, and that calculations of increased efficiency are themselves likely to be overly optimistic. This skepticism, of course, reflects the assumption that the government is not in the market for insurance, and that contractor absorption of risk is of no particular value to the buyer, at least not in relation to its cost. The popularity of incentive contracts is much more easily explained in terms of "sub-optimizing" behavior of individual procurement officers than it is in terms of the objectives of the organization as a whole.

This conclusion is further strengthened by substantial evidence to the effect that "target costs" are strongly influenced by other features of the contract. Insofar as target costs are raised as sharing ratios are raised, efficiency in contract performance is overstated, even after taking into account the cost of insurance.

The use of cost incentives is not justified by the possibility that they may lead to the selection of more efficient contractors (hypothesis No. 7, p. 32). In the first place, it is a major implication of this study that target price is not a good variable upon which to base the choice of contractor. Indeed, it is the buyer's dependence upon this measure which has induced many of the undesirable biases in C_T which have been observed. Second, one could improve the possibility of choosing the most efficient contractor just as well by replacing FPIF contracts with CPFF and then selecting

that contractor who asks for the lowest fee.¹⁶ This approach would also tend to eliminate many of the biases in C_T . Due to the unfortunate inclusion of improper elements in the definition of "costs" (see section II), this procedure would not be perfectly satisfactory either, but it would certainly provide some improvement over present techniques.

In passing, it should be remembered that this skepticism does not extend to the use of "incentives" on performance parameters in a CPIF contract. These parameters tend to reduce the risk of a contract by permitting variability in the product, and the introduction of such flexibility may be of great benefit to the risk-bearer, especially if this happens to be the contractor.

Finally, a word is in order regarding the perhaps surprising position that cost incentives are probably not very effective. This is not to reject the traditional market theory relating production behavior to prices but rather to recognize that typically firms obtain efficiency by institutionalizing it--by introducing new techniques into an existing routine. Furthermore, such introductions are usually experimental--a new device is brought in on a tentative basis: if it works, it is retained, otherwise not. If there is no routine (as in new research and development efforts), there is no opportunity for experimentation and the return to management is extended over such a short time horizon as to make it much less worth while to make efforts to reduce costs. Thus, opportunities for cost control are too individual and short-run to be seriously influenced by incentive provisions.¹⁷ In some cases,

16. Note that the possibility of duplicating the benefits implied by hypothesis #7 further weakens the case for cost-incentives: part of the "savings" which have been experienced are probably due to this factor and are, therefore, obtainable by other means.

17. For an extreme example, North American Aviation recently lost \$250,000 to \$500,000 on a CPIF contract because of the failure of a landing gear on its XB-70 to retract. Yet the test pilot did not even attempt to operate this system by pushing the appropriate switches more than once!

such as maintenance operations, cost-control decisions extend over a repetitive process, the contract runs over a longer time, and the risk factor is much lower; so that the incentive effect is much more likely to be significant.

In short, it must be remembered that prices have an impact upon the accounting (and contract-writing) as well as the operating departments of corporations, and in the short run, it is to be feared that the influence of the former is dominant.